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HEAT CONDUCTIVITY OF TUNGSTEN AT HIGH TEMPERATURES

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ABSTRACT

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Description of an equipment and procedure developed for measuring the heat conductivity of tungsten in the temperature range from 1500 to 3000° K. Heat conductivity is measured by determining the temperature distribution along a wire or strip of foil, heated by a current, in the region where the distribution is exponential. The results obtained for the heat conductivity of tungsten are used to determine the temperature dependence of the Lorentz number. /111*

Author

Augmentation of research on the thermal properties of solids by means of detailed measurements is of importance for those materials which are already covered by experimental data in the literature. New results contribute to determining reliable, reference values for the thermal properties, which are particularly important for the high-temperature region. Guided by these considerations, the authors undertake measurements of tungsten heat conductivity at 1500-3000° K.

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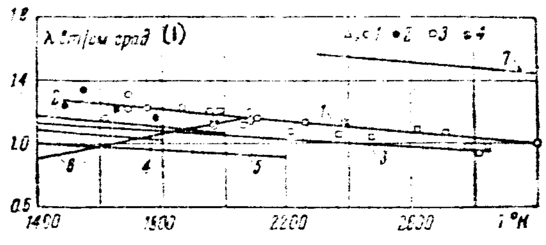
* Note: Numbers in the margin indicate pagination in the original foreign text.

The measurement procedure and apparatus which we described previously (Ref. 1, 2) were employed. Heat conductivity measurements were reduced to determining the temperature distribution along a wire or strip of foil, heated by a current in the region where this distribution is exponential. In order to produce this temperature distribution, a rider creating local temperature non-uniformity was suspended in the section of the wire (foil) having constant temperature. The temperature distribution was measured with a specially-constructed differential, optical pyrometer (Ref. 1). The heat conductivity was determined according to the formula

$$\lambda = \frac{4I^2\rho}{S^2 T_0 k^2}(1 - \Delta) \qquad \left(\Delta = \frac{1}{2}\,\frac{d\ln T_0\varepsilon - 1}{d\ln T_0}, \qquad k = \frac{d\ln(T - T_0)}{dx}\right) \tag{1}$$

k - represents the exponential index of the temperature distribution along the wire (foil); T_0 - the temperature in the absence of the rider; 1 - current strength; ρ - specific resistence; S - the transverse cross-section. The quantity Δ represents a small correction which takes into account the dependence of heat conductivity and the integral degree of blackening on temperature.



(1)- w/cm degree

The measurements were performed in the following order. The temperature distribution along the object being studied was first determined in the absence of the rider, with the aid of a differential pyrometer. This made it possible to detect small temperature distortions in the object, which were caused by defects disturbing its uniformity. (As a rule, these temperature non-uniformities did not exceed a fraction of a degree.) Then the rider was suspended on the sample, and the temperature distribution produced by its presence was determined. The temperature values obtained were read off from the measurement results without a rider. The temperature distribution was measured on a section which was ~ 20 mm long; the maximum temperature difference was 20°. The measurement results, as well as the dependence of the temperature difference $T - T_0$ on the x - coordinate along the sample, were plotted on a graph in a semilogarithmic scale. The magnitude of k was determined on the basis of the angle of inclination of the lines thus obtained.

The figure given above presents the results derived from measuring heat conductivity. The experimental points 1 were obtained for a strip of foil of 2 mm, 60 microns; points 2- for 3 mm, 60 microns; points 3 and 4 - for a wire having a diameter of 0.3 and 0.2 mm. All of these results coincide fairly well; there is no systematic difference. The maximum deviation of the individual points from the average curve 1 is 7%; the mean deviation is 4%. The curves in the figure were constructed on the basis of data presented in the literature: (2) - (Ref. 4); (3) - (Ref. 3); (4) - (Ref. 8); (5) - (Ref. 6); (6) - (Ref. 5); (7) - (Ref. 7). The measurement results derived by D. L. Timrot and V. E. Peletskiy (Ref. 3), Osborne (Ref. 4), Cutler and Cheney

(Ref. 8) were closest to our results.

The results derived from measuring tungsten heat conductivity can be utilized to determine the temperature dependence of the Lorentz number. It was thus found that the Lorentz number decreased monotonically in the temperature interval studied from $3.40.10^{-4}$ at 1500° K to $2.81.10^{-8}$ w cm/degree^2 at 3000° K. Such Lorentz numbers indicate that there is a significant contribution from lattice heat conductivity.

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